# NASA Facts

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**The Earth Observing System Aqua Series**
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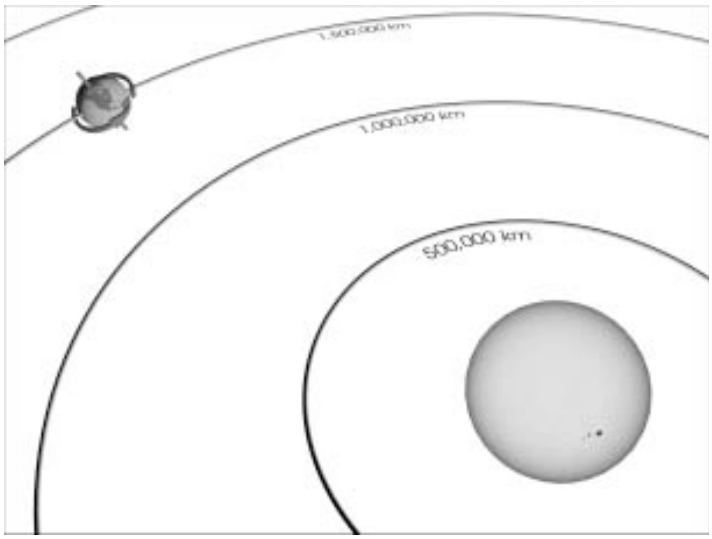
*These articles focus on the overarching science priorities of the EOS Aqua mission.*
*http://aqua.nasa.gov*

# Weather Forecasting Through the Ages

**Introduction**

Imagine a rotating sphere that is 12,800 kilometers (8000 miles) in diameter, has a bumpy surface, is surrounded by a 40-kilometer-deep mixture of different gases whose concentrations vary both spatially and over time, and is heated, along with its surrounding gases, by a nuclear reactor 150 million kilometers (93 million miles) away. Imagine also that this sphere is revolving around the nuclear reactor and that some locations are heated more during one part of the revolution and others during another part of the revolution. And imagine that this mixture of gases continually receives inputs from the surface below, generally calmly but sometimes through violent and highly localized injections. Then, imagine that after watching the gaseous mixture, you are expected to predict its state at one location on the sphere one, two, or more days into the future. This is essentially the task encountered day by day by a weather forecaster (Ryan, Bulletin of the American Meteorological Society,1982).




Earth rotates on its axis once every 23 hours, 56 minutes, and completes one revolution around the sun every 365.25 days.

**Early History**

The art of weather forecasting began with early civilizations using reoccurring astronomical and meteorological events to help them monitor seasonal changes in the weather. Around 650 B.C., the Babylonians tried to predict short-term weather changes based on the appearance of clouds and optical phenomena such as haloes. By 300 B.C., Chinese astronomers had developed a calendar that divided the year into 24 festivals, each festival associated with a different type of weather.

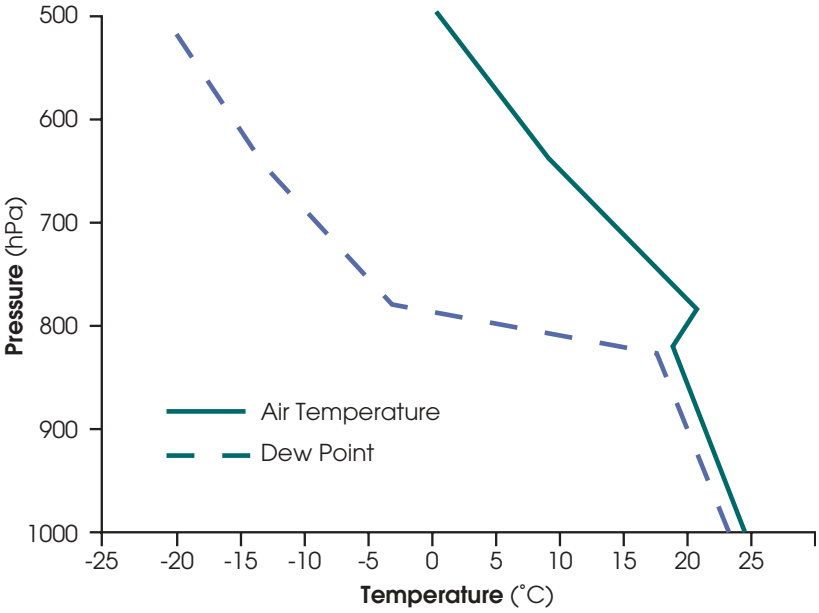
Around 340 B.C., the Greek philosopher Aristotle wrote *Meteorologica*, a philosophical treatise that included theories about the formation of rain, clouds, hail, wind, thunder, lightning, and hurricanes. In addition, topics such

Aristotle, as sculpted by the Greek sculptor Lysippos.

as astronomy, geography and chemistry were also addressed. Aristotle made some remarkably acute observations concerning the weather, along with some significant errors, and his four-volume text was considered by many to be the authority on weather theory for almost 2000 years. Although many of Aristotle's claims were erroneous, it was not until about the 17th century that many of his ideas were overthrown.

Throughout the centuries, attempts have been made to produce forecasts based on weather lore and personal observations. However, by the end of the Renaissance, it had become increasingly evident that the speculations of the natural philosophers were inadequate and that greater knowledge was necessary to further our understanding of the atmosphere. In order to do this, instruments were needed to measure the properties of the atmosphere, such as moisture, temperature, and pressure. The first known design in western civilization for a hygrometer, an instrument to measure the humidity of air, was described by Nicholas Cusa (c.1401-1464, German) in the mid-fifteenth century. Galileo Galilei (1564-1642, Italian) invented an early thermometer in 1592 or shortly thereafter; and Evangelista Torricelli (1608-1647, Italian) invented the barometer for measuring atmospheric pressure in 1643.

While these meteorological instruments were being refined during the seventeenth through nineteenth centuries, other related observational, theoretical, and technological developments also contributed to our knowledge of the atmosphere; and individuals at scattered locations began to make and record atmospheric measurements. The invention of the telegraph and the emergence of telegraph networks in the mid-nineteenth century allowed the routine transmission of weather observations to and from observers and compilers. Using these data, crude weather maps were drawn and surface wind patterns and storm systems could be identified and studied. Weather-observing stations began appearing all across the globe, eventually spawning the birth of synoptic weather forecasting, based on the compilation and analysis of many observations taken simultaneously over a wide area, in the 1860s.




A schematic sounding of air temperature and dewpoint derived from radiosonde data. This sample schematic sounding includes a temperature "inversion" (temperatures increasing with height) at about 800 hPa and reflects atmospheric conditions that frequently precede the development of severe thunderstorms and possibly tornadoes. [1 hectoPascal (hPa) = 1 millibar (mb).]

**Closing**

Only fifty years ago, weather forecasting was an art, derived from the inspired interpretation of data from a loose array of land-based observing stations, balloons, and aircraft. Since then it has evolved substantially, based on an array of satellite and other observations and sophisticated computer models simulating the atmosphere and sometimes additional elements of the Earth's climate system. All this has been made possible by advances in satellite technology, a sweeping acceleration in worldwide communications, and overwhelming increases in computing power. Aqua's AIRS/AMSU/HSB combination should further these advances, enabling more accurate predictions over longer periods.